FISHERY BOARD FOR SCOTLAND.

SCIENTIFIC INVESTIGATIONS, 1912.

No. I.

ON THE EGGS OF CERTAIN SKATES (*RAIA*).

(WITH 5 PLATES).

BY

DR. H. C. WILLIAMSON, M.A., D.Sc., F.R.S.E.,
MARINE LABORATORY, ABERDEEN.

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H. CHAS. WILLIAMSON, M.A., D.Sc., F.R.S.E.,

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(*Plates I.-V.*)

The egg-cases or purses of the different species of Skates differ markedly from one another. They have tests of a somewhat horny nature, and enclose the yellow yolk (ovum) surrounded by the translucent albumen (white yolk).

Beard* described the purses of five species, viz., *Raia batis*, *clavata*, *maculata*, *circularis*, *radiata*. No figures of the purses accompanied his paper. I have prepared drawings of the egg-cases of seven species of skates. Most of the specimens were obtained at Aberdeen Fishmarket by Mr. P. Jamieson, formerly attendant at the Laboratory.

The purse of a skate is somewhat rectangular in shape. It has its four angles produced into curved horns, which vary much in length in the different species. The lateral borders are usually flattened into a more or less broad margin. In *circularis* it is rounded. In *macrorhynchus* it is moulded.

Raia macrorhynchus, Raf. (*Raia nidrosiensis*, Collett). Jumbo Skate (Aberdeen).—This species has the largest purse of the collection. A drawing made from a dried example is shown in natural size in fig. 7. It was not unlike a huge purse of *Raia batis*, but it had no side tendrils. Mr. Eunson presented two purses which were taken out of a skate at Aberdeen in April. They were about $10\frac{1}{2}$ to 11 inches (26·5-28 cm.) in total length. Measured along the middle line they were $9\frac{9}{16}$ inches (24·3 cm.) long. In extreme breadth they measured at the ends, in one case, $4\frac{1}{4}$ and 5 inches (10·7 and 12·7 cm.) respectively, while the breadth across the middle of the length was $5\frac{1}{2}$ inches (14 cm.). In the case of the second, the extreme breadths were, at the ends, $3\frac{15}{16}$ and $4\frac{5}{8}$ inches (10 and 11·7 cm.), and across the middle $5\frac{1}{2}$ inches (13·9 cm.). The lateral edge of the purse forms a high longitudinal ridge.

Raia batis, L.—This fish is known as Skate, Grey Skate, and Blue Skate. Its purse is shown in natural size in fig. 2. It has attached to either side of one end (the lower end, according to Beard) a long golden tendril, composed of fine silken hairs entwined in a soft, rope-like form. The egg-case, when taken from the skate, is of a light amber colour. Its test is composed of two layers which separate readily (fig. 1). The outer layer is of light amber colour, and is

* Beard, J.—"On the Development of the Common Skate (*Raia batis*)." Three plates. *Eighth Annual Report of the Fishery Board for Scotland*, Part III., for 1889. 1890. Pp. 300 *et seq.*

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formed of parallel longitudinal fibres. The inner layer is darker in colour. It is more fragile and brittle than the outer layer; it cracks across in any direction. It is thickened at the side seams of the purse, filling up the angle. In the latter its central region may be lighter in colour than the rest. The inner layer is, however, also formed of longitudinal striæ.

Beard says that slit-like apertures are to be found on the inner side of the extremities of the horns. According to this author, the chief time of reproduction is in March and April, but some eggs are developed and fertilised in all the other months of the year. He considered that development requires nine or ten months. The rate of development in the early summer months was as rapid again as in winter.

A large purse was sent from one of the Aberdeen fish-yards to the Laboratory in January. It is shown in natural size in fig. 6. It was evidently an abnormally big purse of *R. batis*. It was similar in colour, and had tendrils of just about the same length as those of a normal purse. It had been flattened, and the contents were broken up. It was, however, possible to make out that it had contained only one egg. The cavity was a single large one. The ovum had been in the broader half. The yellow yolk was confined to that part, but some of the white yolk had been forced into the other half. The white yolk, although it adheres strongly to the test of the purse, is not organically connected to it.

Raia clavata, L. (The Roker).—The purse of this form is shown in natural size in fig. 8. When taken from the parent it is of a laminarian colour. Stringy appendages were attached to the purse here shown. But some purses of this species have no strings. One purse was of the same length as the one drawn, but much narrower. Beard received the purses of this form from January to June. Bugnion states that the average weight of the egg of this species is 30 grammes.

Raia maculata, Montagu.—Beard received in April a consignment of purses taken from *Raia maculata*. He could find no difference between them and the purses of *Raia clavata*. Holt & Calderwood,* however, figure the purse taken from a female of this species measuring 28 inches (70 cm.) in length (fig. 12). The purse measured $2\frac{5}{8}$ inches (6·7 cm.) × $1\frac{11}{16}$ inches (4·3 cm.). The external surface is smooth.

Raia blanda, Holt and Calderwood.—The purse taken from a female 46 inches (115 cm.) in length, measured, exclusive of the horns, $5\frac{1}{2}$ inches (13·6 cm.) × 3 inches (7·6 cm.)* (fig. 10). The external surface is smooth. It is readily distinguished from the purse of *maculata* by its greater size. There is not much difference in the relative length of the horns in the two species.

Raia microcellata, Montagu.—The purse taken from a female 34 inches (85 cm.) in total length, measured $3\frac{9}{16}$ to 4 inches (9 to 10 cm.) × $2\frac{1}{4}$ inches (5·7 cm.)* (fig. 11).

Raia circularis, Couch. (The Cuckoo).—The purse is seen in natural size in fig. 4. Its horns are very long. When found in the sea the purse is often black. Beard received the purses of this species from February to June.

*Holt, E. W. L., and Calderwood, W. L. "Survey of Fishing Grounds, West Coast of Ireland, 1890-1891. Report on the Rarer Fishes." Five plates. *Trans. Roy. Dublin Society*, N.S. Vol. V. Part IX. 1893-1896.

Raia fullonica, L. (Shagreen Ray).—The purse of this fish resembles that of *circularis*, but it is of larger dimensions (fig. 3).

Raia lintea, Fr.—Two purses were obtained by Mr. Erlendsson in a female taken in 70-80 fms., 16 miles S.W. of Snaefellojoteul, Iceland, in June. The purse resembles that of *Raia fullonica* (fig. 3), but it is larger. One example had a body 11 cm. long by 8 cm. wide. The longer horns were 10 to 11 cm. in length. The little horns were shorter than the little horns in *Raia fullonica*.

Raia radiata, Donovan.—This purse is the smallest of those described in this paper. The test is felty on the outside. Some silky hairs hung loosely from the purse. Beard says that it is always quite flat on one side and strongly convex on the other. The embryo is usually found under the flattened side of the purse. He further states that the purses of this species were plentiful at Aberdeen in February and March, and continued to be got until June at least. I received from Mr. Eunson two purses taken from the skate in October.

Raia oxyrhynchus, L.—This purse (fig. 9) was found in the cloaca of the fish. It has a felty external surface. It contained no ovum. The sides of the end of the purse marked *x*. in the figure were adhering together, but they were readily separated. The remains of yellow yolk were found inside the purse. The egg had been expelled by violence before the mouth of the purse had been properly sealed. Along the lateral edge of the purse there was a border of woolly stuff which resembled the material of which the tendrils of *batis* were composed, but here it was attached along the whole edge.

Raia alba, Lacép : *Raia marginata*, Lacép.—The Bottle-nose Ray. A purse taken from the bottle-nose ray is described by Holt.* It does not appear to differ greatly, in so far as concerns the shape of its body, from that of *R. batis*. Its greatest length in the middle line was $6\frac{7}{8}$ inches (17·4 cm.), and its greatest breadth was $5\frac{7}{16}$ inches (13·8 cm.). The posterior horns, about $3\frac{7}{16}$ inches (8·7 cm.) in length, are stout, flattened, and tapering. They are strongly bent in a ventral direction, and incline somewhat towards each other. The anterior horns are long and ribbon-like. They are $9\frac{5}{8}$ inches (24·5 cm.) in length, and they taper from a width of $\frac{7}{8}$ inch (2·2 cm.) to one of about $\frac{1}{4}$ inch (·6 cm.) at the extremity. They are very thin, and are supported by a thickened longitudinal ridge. Each horn is inwardly curved so as to meet and cross its fellow. The axis of the ribbon is gradually rotated. The fine longitudinal ridges on the surface of the purse are most distinctly beaded. Each is, in fact, beset by minute transverse crests. This beaded appearance seems to be quite characteristic. Couch † and Day ‡ describe a purse which they believed to belong to *Myliobatis aquila*. It is the purse of the Bottle-nose Ray.

According to Bugnion, § the average weight of the egg of *R. alba* is 90 grammes.

* Holt, E. W. L.—"The Bottle-nose Ray (? *Raia alba*, Lacép), and its Egg-purse." *Journal of the Marine Biological Association*. Vol. V. (N.S.). 1897-99. Pp. 181-183.

† Fishes of Great Britain.

‡ British Fishes, i.

§ Bugnion, E.—Le Developpement des Selaciens (*Acanthias vulgaris*, et *Scyllium canicula*) et des Raies (*Raia alba*, *R. clavata*). Procés-Verbaux. Pp. xxxi-xxxiv. Bulletin de la Société Vaudoise des Sciences Naturelles. 3e S. Vol. XXX. No. 115. Lausanne, 1894.

Day states that he had received a purse of *Raia alba*. The purse measured 16 inches × 6½ inches. It is possible that the parent of this purse was *macrorhynchus*.

The following paragraph is extracted from Beard's paper :—"The author inclines to the view that the purse of a skate is partly formed in the oviduct before the egg leaves the ovary. Fertilization must be effected in the upper limit of the oviduct. For some weeks at least the egg undergoes development within the maternal oviduct, and there it normally lies till the first traces of the embryo appear. It is then laid by the mother skate, and undergoes its subsequent long development at the bottom of the sea. Never more than two eggs, one in each oviduct, are found in a single skate."

Bugnion says that the test of the egg of the skate is formed in a glandular thickening of the oviduct (*glande nidamenteuse*). At this part, the cavity of the organ is dilated, flattened, and exhibits four horns or prolongations in which the four points of the egg are moulded. There is only one egg in the oviduct in the process of development. Impregnation of the egg is effected in the superior part of this organ before the test is formed. The freshly laid egg does not enclose an embryo, but only a little scar similar to that of the egg of the domestic fowl before incubation. In fifteen days after the extension of the egg, the embryo measured 7 mm. in length.

While there seems to be no doubt that the egg is usually extruded while the embryo is in a very early stage of development, it has been asserted by fishermen that little skate have been found inside purses taken out of the mother.

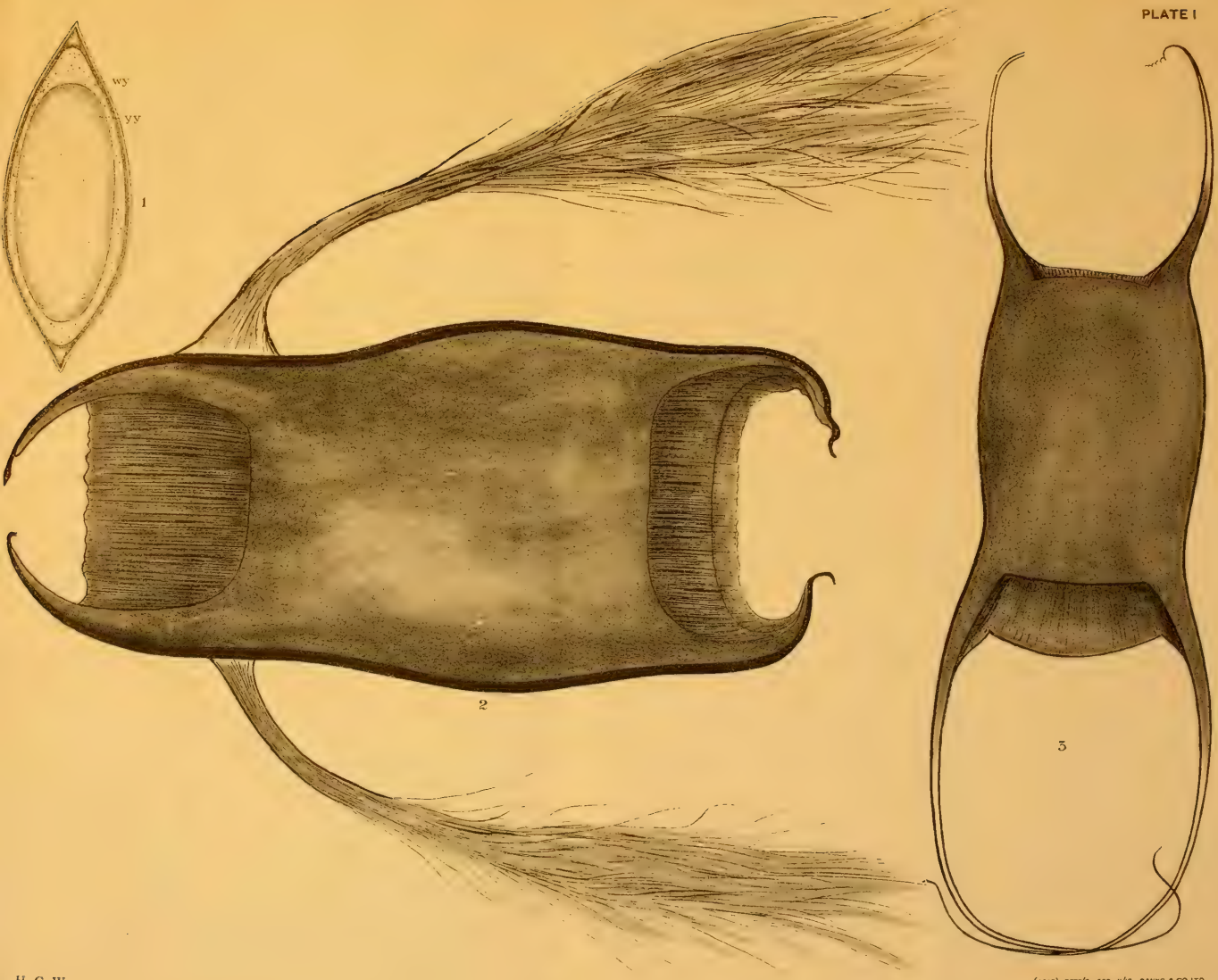
Eggs of skate have, Mr. Thomson informs me, been taken in considerable numbers on ground 16 miles south-south-east of Aberdeen by the trawl towing off the shoal water on Aberdeen Bank.

EXPLANATION OF PLATES.

Plates I., II., III., IV., V.

Fig. 1. Transverse section of purse of *Raia batis*; approximately natural size. *yy*, yellow yolk (ovum); *wy*, white yolk.
,, 2. Purse of *Raia batis*, natural size.
,, 3. ,, *Raia fullonica*, ,,
,, 4. ,, *Raia circularis*, ,,
,, 5. ,, *Raia radiata*, ,,
,, 6. Abnormal purse of *Raia batis*, natural size.
,, 7. Purse of *Raia macrorhynchus* (dried specimen), natural size.
,, 8. ,, *Raia clavata*, natural size.
,, 9. ,, *Raia oxyrhynchus*, ,,
,, 10. ,, *Raia blanda*, reduced. (After Holt and Calderwood).
,, 11. ,, *Raia microcellata*, ,, ,, ,,
,, 12. ,, *Raia maculata*, ,, ,, ,,

PLATE I



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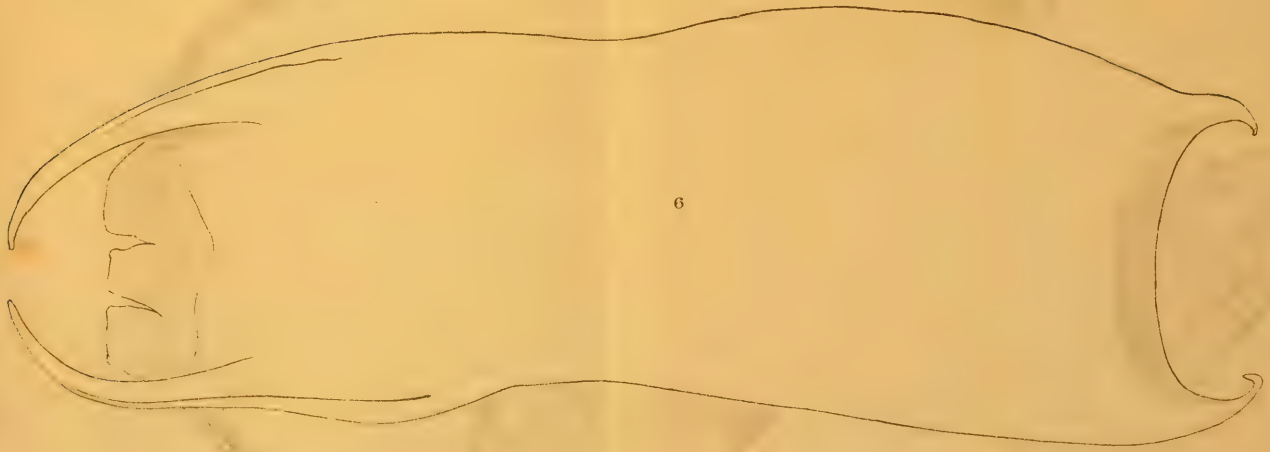

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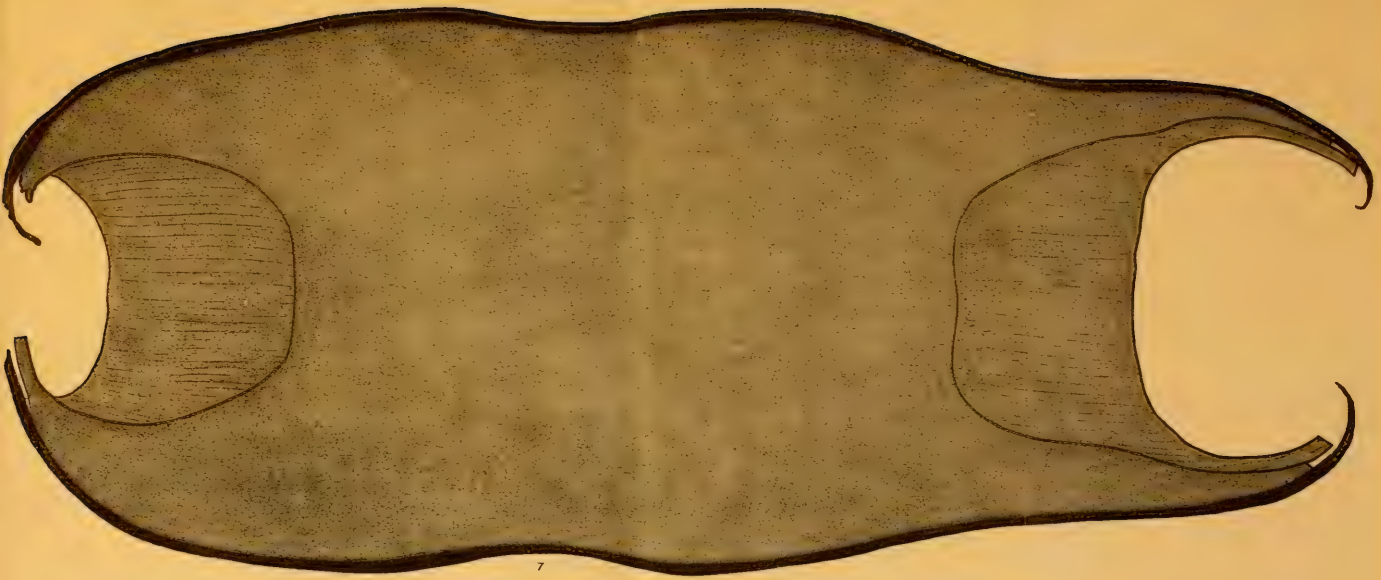

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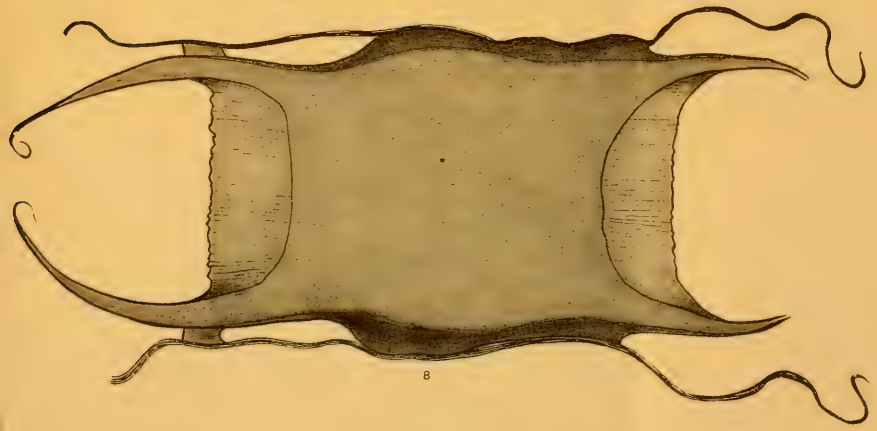

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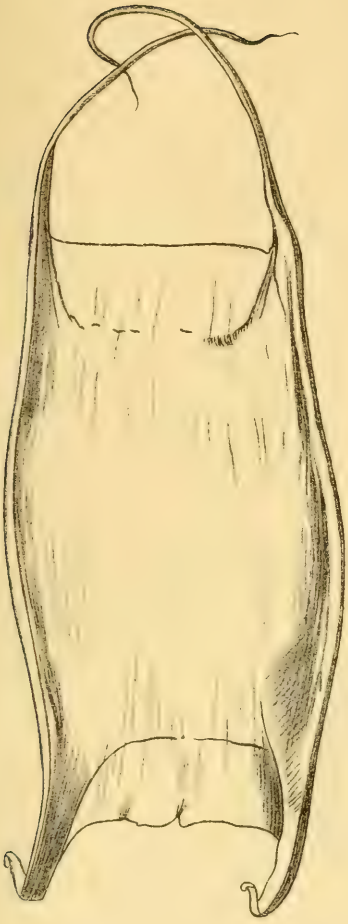

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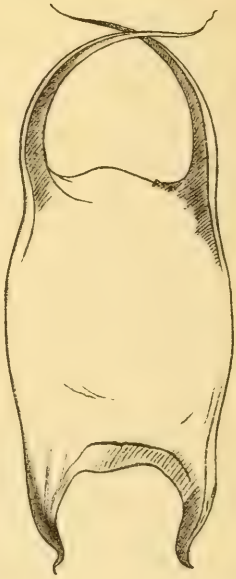
11.



12.

PURSES OF SKATES.

After Holt & Calderwood.

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FISHERY BOARD FOR SCOTLAND.

SCIENTIFIC INVESTIGATIONS.

1912.

No. II.

THE DISTRIBUTION OF THE LARVÆ OF THE EEL IN SCOTTISH WATERS

(WITH 1 CHART).

BY

ALEXANDER BOWMAN, D.Sc.

This Paper may be referred to as:
"*Fisheries, Scotland, Sci. Invest., 1912*, II." (*Dec. 1913*).

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FISHERY BOARD FOR SCOTLAND.

THE DISTRIBUTION OF THE LARVÆ OF THE EEL IN SCOTTISH WATERS

(*With One Chart*).

By ALEXANDER BOWMAN, D.Sc.

There is no more fascinating chapter in the history of marine investigation than that which tells of the elucidation of the life story of our common fresh-water eels. Those two dominant instincts in the life of a fish, viz., the instinct to feed and the instinct to breed, compel our European eels to seek at one period of their existence the fresh waters of our rivers and streams, in which they feed and grow, and at another period for the purpose of breeding, such utterly different physical conditions as the warm deep waters of the Atlantic. One can understand now how a profound mystery surrounded the propagation of this species for so long a time, and how such a mystery could not be cleared away save only by costly oceanic exploration, and by the development of modern engines and methods of research.

Only within the last few years have the main facts of this story been made clear, chiefly through the brilliant researches of the Danish and Norwegian investigators, Dr. Johann Schmidt and Dr. Johann Hjort, which researches followed and in a large measure extended the discoveries of Professor Grassi in regard to the eels of the Mediterranean.

We now know that the fresh-water eels which inhabit the rivers of Western Europe were born in mid-Atlantic over great depths, and that they themselves, as they grow up, must seek again the deep, warm, salt water before they can reach maturity and reproduce their kind. The young larvæ are found far out in the Atlantic, and as they grow up into quaint, transparent, leaf-like forms (Leptocephali), are carried by the prevailing currents towards the edge of the Continental plateau. There, outside the 1000-metre line, they are found as fully-grown Leptocephali during the summer months, over the long stretch from the westward of the Faeröe Islands to northward of the Coast of Spain.

Towards the end of summer (August-September), these fully-grown, leaf-like larval eels begin a retrogressive change, and, aided again by the prevailing currents, make their way towards the coast, gradually assuming the form and appearance of an elver, or young eel.

It is clear, therefore, that the stock of eels in the rivers which flow into the Baltic and North Sea must be derived from the Atlantic

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either by way of the English Channel or round the North of Scotland.

The records from Scottish waters are of value, therefore, not only in extending our knowledge of the northerly limits of distribution of the Leptocephali, but also in defining more precisely the time and intensity of the migration of the young "glass eels" round the North of Scotland.

The Larvæ of the Common Fresh-water Eel.

Of the Leptocephalis larvæ of the Common Eel only 13 specimens have been obtained in the course of our work; and that the Scottish records of Leptocephali are not more numerous is simply to be accounted for by the infrequency of our visits to the deep Atlantic waters of the west coast. Dr. Schmidt has shown that the Leptocephali are found outside the 1000-metre line, but in decreasing abundance towards the north. One of our thirteen specimens was got within this 1000-metre area at 58° 43′ N. 9° 45′ W. on August 23rd, 1910. It was at stage three of the retrogressive metamorphosis, and is thus only an additional record to the normal distribution found by Schmidt. Most of our Scottish stations have been to the north of this 1000-metre line, and the other twelve specimens captured are of interest as being apparently sporadic examples which have been driven early from the main stock of Leptocephali by the strong current running towards the north-east.

Perhaps the most interesting of these records is an example which had been carried away to the N.E. over the Wyville-Thomson ridge, into the Faeröe-Shetland Channel, and which even in the month of August had reached a higher latitude than the north point of Shetland; it was found in 61° 17′ N. 1° 22′ W. This specimen, 75 mm. in length, was not very far advanced in its metamorphosis, and had only reached stage two on the 11th of August. A specimen which was caught on July 6, 1904, at 59° 61′ N. 6° 00′ W., and which still retained its larval teeth, not having begun the retrograde metamorphosis, shows us how in some years the prevailing drift may drive the larvæ inwards very early. The records of the other two stations also help to show this, and indicate that even in August many of the larvæ are far advanced in their retrograde metamorphosis. At 59° 15′ N. 7° 10′ W. one had proceeded so far as stage four, one had reached stage three, another between stages two and three, whilst the other six specimens taken on the same station at the same time were at stage two.

In spite of the fact that our observations are comparatively few, and that our work in the deep waters has been practically confined to the months of July and August, these records of the Leptocephali help us considerably towards an understanding of the route taken round the North of Scotland by the immigrating larvæ. Had our work in the Atlantic, and that around the North of Scotland, extended through the months of September, October, and November, then we should have doubtless been able to trace in a more thorough way the migration of the Leptocephali, and of the glass-eel into which they presently turn. Our more continuous work in the North Sea itself throws a good deal of light upon the distribution of these glass-eels.

The Distribution of the Young Glass Eels.

Our observations in the North Sea extend over a period of nine years, from April, 1904, to March, 1913.

From the table supplied, it is seen that all the records of glass-eels occur within the period of the year extending from November to May, and although more numerous observations have been made in the other half of the year, from April to November, no records have been made of these transparent glass-eels in the northern North Sea. Thus the Scottish records confirm the statements made by Schmidt that the migration of the glass-eels is limited to the winter and spring months, and that these glass-eels are derived from the metamorphosing stages of the previous summer found out in the Atlantic. The records of the Leptocephali on the west, and the time of occurrence of the larvæ, in the North Sea show us that an annual stock is passing inwards round the North of Scotland in the months of September to January or February. Our records of the Leptocephali indicate that the migration in the North of Scotland is aided greatly by the strong north-easterly current, and the occurrence of glass-eels in the North Sea as early as November points to the fact that the young eels reach the North Sea via the North of Scotland at least as readily as by the apparently much shorter route through the English Channel.

Schmidt has shown that this strong easterly current which aids the eels in their migration also carries enormous quantities of Atlantic pelagic organisms into the North Sea. Thus he shows that such passive organisms as Salps *(Salpa fusiformis)*, which were limited in the North Atlantic in May to the west of the Hebrides, and were absent from the Norwegian and North Seas, were found in these latter areas towards the end of July and August, having pushed themselves to the north, and also into the North Sea, in large numbers.

Now the larval eels were also found at these localities to the West of Scotland from May to September, yet from our records the glass-eels do not arrive in the North Sea much before November, that is to say, some months after the advent of the Salps; although the larval eels are by no means such passive organisms as Salps. The records of capture help us considerably, for it may be said almost as an invariable rule that the glass-eels are only caught at the surface at night. There are no surface records for mid-day hauls, and, indeed, the greatest number obtained in one haul of quarter-hour duration was 18, got at St. 42 (56° 28′ N. 0° 53′ W.) on February 11, 1911, about 3 a.m. This peculiarity has been well brought out by Johansen for the North Sea, Skagerak, and Cattegat; and Schmidt has also shown that the Leptocephali behave in a similar manner, approaching the surface waters during the darkness. These diurnal vertical movements must play no inconsiderable part in modifying the influences of the surface currents on the horizontal distribution of the eel-larvæ, and it is therefore more easy to understand why the glass-eels should be later in arriving in the North Sea through the influence of the currents than some other pelagic but more passive Atlantic organisms.

The first records of the arrival of the new stock of eels in Scottish waters were made in November. Two of the specimens were pro-

cured on the 6th November, 1907, at Station 3 (Lat 59° 10′ N. Long. 1° 27′ W.), and they seem to suggest that the glass-eels gain access to the North Sea through the passage between Orkney and Shetland. The two specimens captured on 21st November, 1912, at Lat. 58° 30′ N. 2° 30′ W., right at the Pentland Firth, on the other hand, suggest the view that part of the stock may come through the Pentland Firth into the North Sea.

The most interesting record is probably one made in December, 1902. A specimen was taken by H.M. "Jackal" on the 8th of this month, at Lat. 61° 12′ N. 10° 52′ E. Here is an individual which has been carried very far to the north-east, even as early as December; but this record is the more easily explicable when taken in together with the record of the Leptocephalus caught to the north of Shetland in the month of August. There is no doubt that a great part of the supply of eels to the northern shores of Norway is derived from the Atlantic by way of the Faeröe-Shetland Channel, across which the larvæ are carried early by the rapidly-moving Gulf-stream current. Part of the stock of eels to the west of the Hebrides must be carried towards the North of Scotland, and split fan-like by the intervening Orkney and Shetland Islands before entering the North Sea.

The other records for December are also interesting, although only single specimens have been found at each observation station. In December, 1908, as early as the 3rd of the month, glass-eels had penetrated into the North Sea as far south as a line east from the Firth of Forth. This is the most southerly limit of our observation stations, so that in reality the stock of glass-eels may have extended much further south. There is no doubt but that these specimens had come from the north, and it should also be noted that they were captured at localities at some considerable distance from the coast. The probability is that these would have been carried still further south later in the year. The stations which have been examined in January are, unfortunately, very few, but our February observations are numerous and the records of glass-eels are as frequent as are those of December. This is undoubted proof, therefore, that the glass-eels are fairly general in their distribution over the northern North Sea in the winter months, from December to February, and that they are found even far from the coast. On the other hand, the March observations, which have extended over as wide an area and are more numerous than the February ones, give much fewer records, and the glass-eels captured have been found comparatively near to the coast. Apparently the great annual wave of immigrating glass-eels has passed over this area between the months of December and February. That this is probably the case is further corroborated by the fact that the glass-eels have completely disappeared from our area in the month of April. Our area of investigation is necessarily limited in extent, and there is no reason for supposing that there are no glass-eels beyond the area investigated.

The line of stations running east from the Firth of Forth has proved very rich in glass-eels during the first months of the year, numerous records being obtained from the same stations in different years. It is obvious that the glass-eels not only spread over the northern North Sea, but that many are carried coastwise down into the southern portion; and we are justified in saying that the

southern half receives a portion of its stock, at any rate, from the North of Scotland. The absence of records of glass-eels in the southern North Sea from November to February may be due to the lack of observations during these months. For, as stated by Schmidt, Gilson obtained large numbers off Cape Griz Nez in the beginning of February. We cannot judge too accurately the time of arrival of the glass-eel off the coast from the time of the ascent of the elvers of the neighbouring streams; for, as we see from the Scottish records, the glass-eels may be off the coast as early as December, although the ascent of the rivers is not apparently undertaken much before the month of May. The records for the winter months in the southern North Sea are very incomplete. There are Danish records, however, for the months of March and April, and from these it is obvious that part of the stock is at least derived from the north. Johansen has given February as the date of the earliest record for the "Sound," whilst the pelagic glass-eels occur in quantities in the salter parts of the Danish waters in the months of March and April. Thus these records are in good agreement with the times of arrival of the glass-eels off the Scottish coast, and confirm the view that the Baltic derives part of its stock of eels by way of Scottish waters. The Norwegian record of a glass-eel taken in April in the northern part of the North Sea might possibly be that of an individual which had entered the North Sea early by way of the North of Scotland, and had been carried by the anti-cyclonic current round the North Sea.

Our records for Scotland are too few, and belong to too many different year groups, to make any comparison as to the relative sizes of the Leptocephali and glass-eels with those from other localities; but the reduction in size during the metamorphosis is brought out in the table.

The annexed chart illustrates, in a summary way, the points already set forth. We see the Leptocephali distributed in the month of August from westward of the Hebrides to the north of Shetland, in the line of the Gulf-stream current. Observation in the same region being lacking for the months of September and October, we lose track of the migration during that period. But we next pick up the young glass-eels in the month of November, just within the North Sea, to the eastward of the Pentland Firth and the Fair Isle Channel. In the middle of the North Sea, all the records relate to the months from December to February. On the other hand, the whole of the observations in the eastern part of the North Sea, eastward of 2° E., including all those in the region of the Skagerak and on the Norwegian coast, are for the months of March and April. The same is true of the observations within the Firth of Forth, and much the same is indicated also by those in the Moray Firth. The net result, accordingly, is that the Leptocephali, in their passage round the North of Scotland, are metamorphosing into glass-eels in the autumn months; that a great stream of them is passing through the northern North Sea about December and thereafter till February; while from this central stream the glass-eels spread coastwards, on either side of the North Sea, reaching the coast about March and April. They then ascend the rivers as "elvers," in May or during the latter part of April, especially during the first half of May.

Leptocephali of the Conger Eel.

We have only one record of the Leptocephalus of the Conger caught during these nine years' investigations, and it was taken on the 27th August, 1911, at 50° 58′ N. 2° 27′ W. Dr. Fulton has, however, given two records for the Moray Firth and a record of two specimens captured in Aberdeen Bay, whilst M'Intosh and Masterman also record two which had been captured on the west coast of Scotland.

The combined records for the east coast give us some idea of the time of arrival of the young Conger in the northern North Sea. The stage in the retrograde metamorphosis of our specimen apparently lies between those of Fulton's two specimens. The larva is 128 mm. long, 11 mm. broad, and has lost its larval teeth.

According to Schmidt, the Conger propagates both in the Mediterranean and in the eastern part of the Atlantic between 30° and 40° N. Lat., but not off the shores of the British Islands or France, nor further to the north and east. On account of the long pelagic life of the larvæ they become distributed over very wide areas.

Schmidt has also shown that the Conger spawns in spring and summer in the warm salt water of the south, and by the end of the first winter the Leptocephali have reached a size of about 5 cms. Our Scottish specimens are, therefore, of considerably greater age, and are perhaps about two years old, having been carried very far from their original home.

The records, although so few, are wonderfully consistent with those of the fresh-water eel, and when the specimen caught by Collett on January 12th, 1898, is taken into consideration there is no doubt but that the larvæ of the fresh-water eel and the Conger gain access to the shores of northern Europe by the aid of the same prevailing physical conditions. One would naturally expect a more extended area for the Conger, since the duration of its larval life is much greater than that of the fresh-water eel.

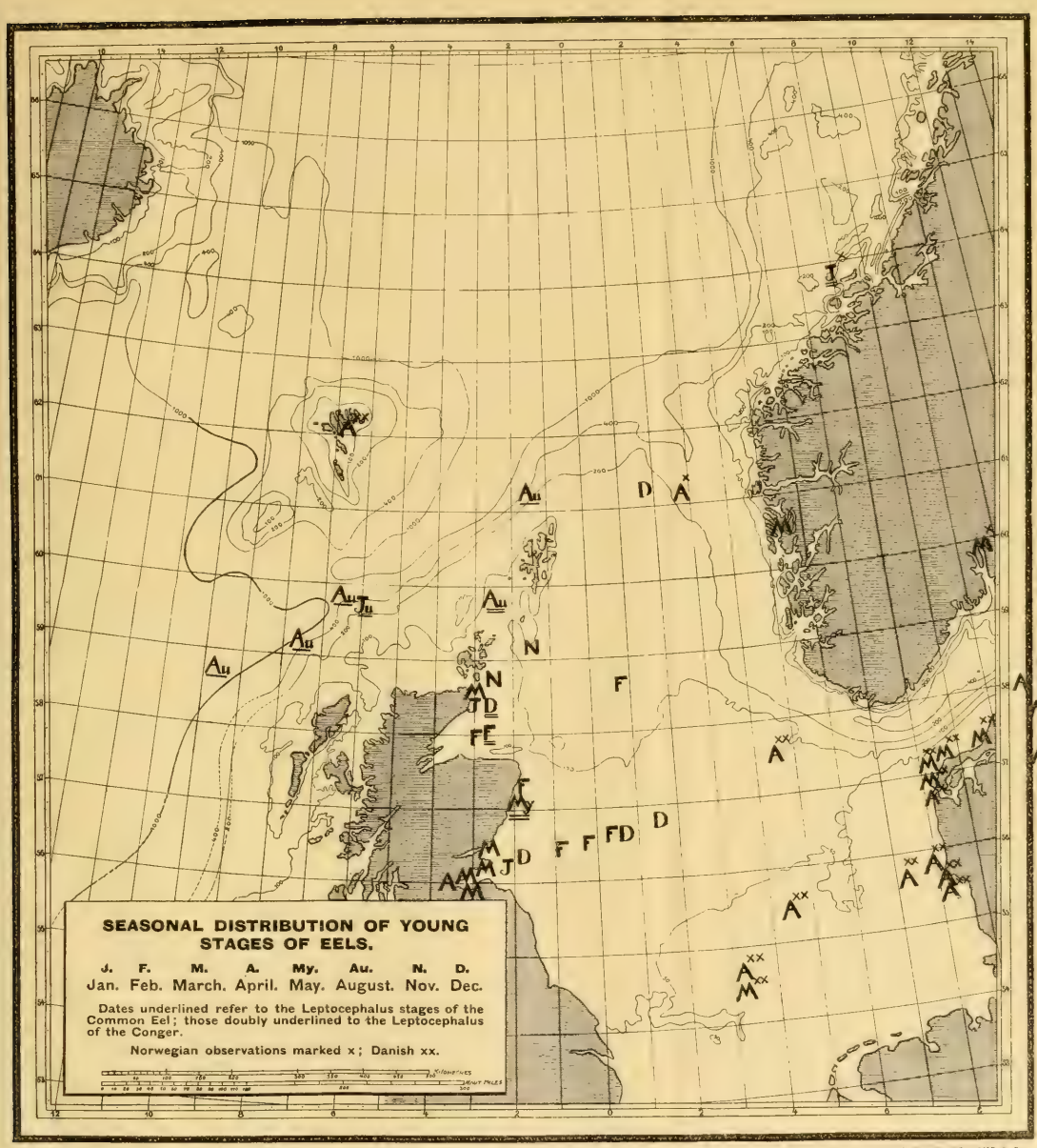

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TABLE I.

Records of Leptocephali of *Anguilla vulgaris.*

Month.	Year.	Date of Month	Station.	Apparatus.	Depth of Apparatus.	Duration of Haul.	Stage of Devpt.	Size.
July	1906	6	59°41′N. 6°00′W.	Young Fish Trawl.	230m.	½ hr.	1	75 mm.
Aug.	1910	23	58°43′N. 9°45′W.	Do.	600m.	Do.	3	79 mm.
	1911	11	61°17′N. 1°22′W.	Do.	250m.	Do.	2	75 mm.
		23	59°15′N. 7°10′W.	Do.	600m.	Do.	2	68-68-68 71-72 mm.
							2-3	66 mm.
							3	70 mm.
							4	62 mm.
					60m.	Do.	2	82 mm.
			59°50′N. 6°16′W.	Small Trawl.	478m.	1 hr.	2	77 mm.

TABLE II.

Leptocephali of *Conger vulgaris.*

Aug.	1911	17	59°58′N. 2°27′W.	Small Trawl.	102m.	½ hr.	—	128 mm.
Dec.	1903?	27	Smith Bank (Moray Firth)	Small mesh Cod-end Otter trawl	28 fms.	—	—	145 mm.
Feb.	1903?	12	Moray Firth South of Smith Bank.	Do.	24 fms.	—	—	123 mm.
May	1904	4	Aberdeen Bay.	Do.	4-5 fms.	—	—	—

TABLE III.

Record of Glass Eels.

Month	Year.	Station. Lat. Long.	Depth of Station.	Apparatus.	Depth of Apparatus	Date.	Time.	Duration of Haul.	No. of Species.	Size in mm.	Average Size.
November.	1907	3	metres 113	1 metre Cheese Cloth	113	16	Midnight.	15 min.	2	73-74	
	1912	58°30′N. 2°30′W.	70	Do.	35	21	—	Do.	1	67	71mm. (67-74) {4}
					70	21	—	Do.	1	70	
December.	1902	61°12′N. 1°52′E.	—	Do.	0	8	5 p.m.	Do.	1	75	
	1906	44	57	Do.	0	20	6 p.m.	Do.	1	64	
	1908	41*a*	95	Petersen Young Fish Trawl	95	3	7 p.m.	30 min.	1	71	70·5 (64-75) {4}
		41*b*	92	1 metre Cheese Cloth	92	3	10.30 p.m.	15 min.	1	72	
February.	1906	42	71	Do.	0	17	8.30p.m.	30 min.	2	67-74	68·1 (59-74) {37}
				Do.	10	17	Do.	Do.	1	69	
				Do.	35	17	Do.	Do.	1	69	
				Petersen Young Fish Trawl	0	17	Do.	Do.	1	70	
					35	17	Do.	Do.	2	67-70	
		41*c*	78	1 metre Cheese Cloth	0	18	1 a.m.	Do.	2	65-73	
		41*b*	86	Do.	0	18	5.30p.m.	Do.	2	63-68	
				Do.	5	18	Do.	Do.	1	71	
		30	60	12″ fine Silk	V	19	8 p.m.	—	1	67	
				Petersen Young Fish Trawl	30	19	9 p.m.	30 min.	2	65-66	
	1907	41*c*	80	Do.	80	5	11 p.m.	Do.	1	68	
		38	110	1 m. Cheese Cl.	0	7	1.30a.m.	15 min.	2	67-74	
	1908	Cruden	26	Do.	26	3	6 p.m.	15 min.	1	71	
		38	144	Do.	0	20	9 p.m.	15 min.	1	69	
	1909	41*c*	70	Do.	0	13	3 a.m.	Do.	1	73	
	1911	42	74	Do.	0	11	3 a.m.	Do.	18	$\frac{1}{59}$ $\frac{1}{63}$ $\frac{1}{64}$ $\frac{2}{65}$ $\frac{2}{66}$ $\frac{2}{67}$ $\frac{2}{68}$ $\frac{2}{69}$ $\frac{1}{70}$ $\frac{1}{71}$ $\frac{1}{72}$ $\frac{1}{73}$	
March.	1906	Sinclair Bay	47	12″ fine Silk	V	21	—	Do.	1	65	
		VI. F. of Forth	28	Do.	V	29	—	Do.	1	67	
	1911	III. F. of Forth	19	1. m. Ch. Cl. attached to Trawl	18	23	—	Do.	1	63	
		IV. F. of Forth	13	Do.	13	25	11.30 a.m.	1 hour	10	$\frac{1}{63}$ $\frac{3}{64}$ $\frac{2}{65}$ $\frac{2}{67}$ $\frac{1}{68}$ $\frac{1}{69}$	65·46 (63-69) {13}

TABLE III*a*.

Further Records of Glass Eels in Scotland; from Williamson, "On the Reproduction of the Eel," S.F.B. XIII.

Date.	No. of Specimen.	Size in mm.	Locality.
January 12–14, 1891 ...	1	66	Bottom Tow Net, off Sarclet, Caithness.
January 28–30, 1891 ...	2	65	Bottom Tow Net, E. of May Island.
March 1, 1895	1	70	M'Intosh Net, Inverkeithing Bay, F. of Forth.
March 21, 1891	1	65·7	M'Intosh Net, off Anstruther, F. of Forth.
March 28, 1889	1	65	Midwater Net, St. Andrews Bay.
April, 1885	1	66	Dug up on Sands, St. Andrews.
April 12, 1892	1	71·5	M'Intosh Net, Culross, F. of Forth.
May 8, 1895	1	67·5	Saltwater Pool, St. Andrews.

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